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Thermal Buckling of Temperature Dependent FG-CNT Reinforced Composite Conical Shells

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Abstract

In this research, linear thermal buckling of a composite conical shell made from a polymeric matrix and reinforced with carbon nanotube fibers is investigated. Distribution of reinforcements across the shell thickness is assumed to be uniform or functionally graded. Thermomechanical properties of the constituents are temperature dependent. Under the assumption of first order shear deformation shell theory, Donnell kinematic assumptions and von Kármán type of geometrical nonlinearity, the complete set of equilibrium equations and boundary conditions of the shell are obtained. A linear membrane analysis is carried out to obtain the pre-buckling thermal stresses of the shell. Adjacent equilibrium criterion is implemented to establish the stability equations associated with the buckling state. The resulting equations are discreted by means of trigonometric expansion through the circumferential direction and discrete singular convolution method through the shell length. The established eigenvalue problem is solved iteratively to obtain the critical buckling temperature and critical mode number. Parametric studies are presented to explore the influences of semi-vertex angle, volume fraction of CNTs, distribution pattern of CNTs and boundary conditions. It is shown that, conical shells with intermediate carbon nanotube volume fraction do not have, necessarily, intermediate critical buckling temperature.

Keywords: Thermal Buckling, Functionally Graded Carbon Nanotube Reinforced Composite, Singular Discrete Convolution, Conical Shell.

1 Introduction

Carbon nanotubes (CNTs) have attracted increasing attention in recent years due to their exceptional thermal, mechanical and electrical properties. For example, Their Young's moduli are superior to all carbon fibers with a value greater than 1 TPa and its density can be only 1.3 g/cm^3 [1]. Due to such interesting features, CNTs are selected as a promising candidate to reinforce the composites. [1].

Functionally graded materials (FGMs) are also known as a class of novel materials with fascinating characteristics. Literature on the subject of FGM plates and shells is wealth enough. An overview of the works on the subject of FGM solid structures is provided by Liew et al. [2].

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